Formation of desert rose structures in vacuum plasma sprayed electrodes for alkaline electrolysis

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The EU FCH-JU RESelyser project is concerned with the development of high pressure, high efficiency and low cost alkaline water electrolysers that can be operated variably and intermittently to meet the demands for integration into energy networks relying on fluctuating renewable energy. The project utilizes NiAlMo alloy electrodes produced at the German Aerospace Center (DLR) by vacuum plasma spraying (VPS). VPS results in a heterogeneous microstructure consisting of a multitude of intermetallic phase sub domains and pores. Prior to electrolysis operation the electrodes are activated by leaching of Al and some Al containing intermetallic phases leaving micrometer pores and nanometer dendritic pores increasing the surface area available for the electrolysis reactions.
The vacuum plasma sprayed electrodes were analyzed by high resolution SEM and TEM before and after electrolysis operation and after storage in water. Analyses of cross sections and electrode surfaces revealed desert rose like nano flake structures on the surface and in the pores on several electrodes. The formation of the desert rose structure appeared to be related to the electrolysis operation as well as the duration of storage in distilled water. The size of the faceted flakes varied from tens of nm to a couple of µm where the thickness varied from a few nm to ~50 nm. The desert rose structure was confirmed by TEM to consist primarily of NiO and Al_2NiO_4 like phases (similar lattice parameters). The possible implications for the application and performance of the electrodes are discussed.

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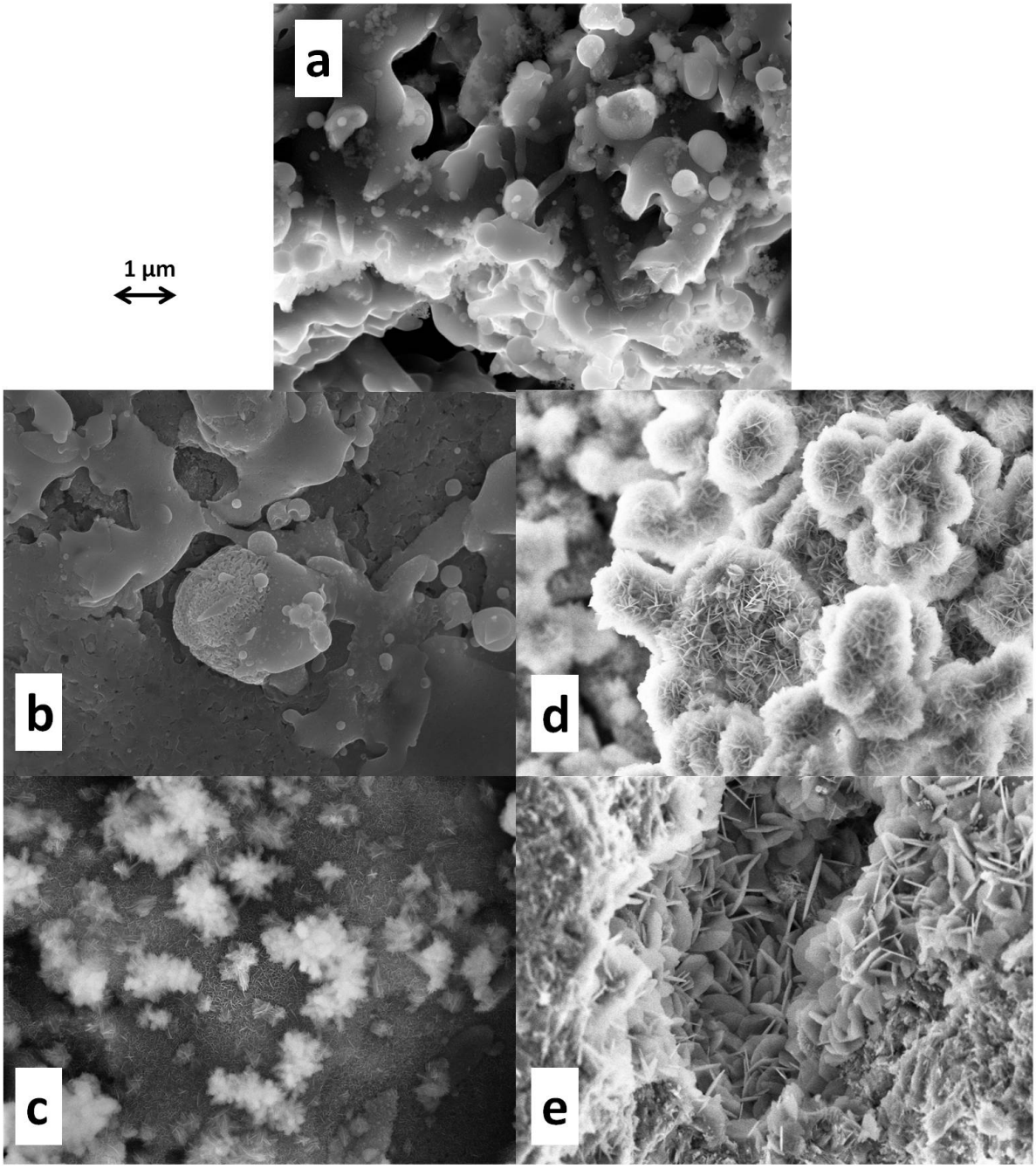

Fig. 1: Formation of desert rose nano flakes on the electrode surface and in pores. SEM images of surface a) as sprayed; b) leached, washed and dried; c) leached, washed and stored in water 3 d; d) leached, washed, stored 120 d in water, and operated as electrode for ~30 min.; e) leached, washed, stored 90 d in water, and operated as electrode for 28 d.